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"No One Said Girls Could Do Engineering": A fresh look at an old problem

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***Abstract**:*

Previous work has drawn attention to what, in many respects, appears to be an insurmountable problem, the lack of women and girls in engineering. The debate about why young women are not attracted to engineering mostly focuses around issues of gender, with the profession stereotypically perceived as being more suitable for men. In seeking to investigate why this should be the case a participatory research approach was adopted in which two 17 year old female High School students were employed to interview their peers about their perceptions of engineering as a career. This paper presents some of the emergent findings of this research.

In total twenty teenage girls from two city centre Schools were interviewed. The two teenage researchers developed the questions themselves, focusing on issues they identified as being important factors informing girls' views of engineering. This approach provided a 'new' perspective – looking at the topic through the eyes of the target sample group. By drawing attention to some of the issues around gender and engineering, this paper contributes to current debates in this area – in doing so it provides a fresh look at an old problem and offers some workable solutions for 'how to get more girls into engineering'.

Introduction

At a time of unprecedented environmental, economic and social insecurity, the need for society to find practical and realistic solutions to a wide-range of previously unpredicted and unimagined predicaments has never been so important. Within this climate of uncertainty, Engineers find themselves increasingly expected to become society's problem-solvers, with much emphasis being paid to the pivotal role engineering has to play in moving society forwards (IMechE, 2009; RAEng, 2008; Spinks et. al, 2006). Despite such demands, Engineering Faculties in the UK find themselves struggling not only with attracting suitable candidates onto Programmes, but also with high levels of attrition, meaning that student retention is a major issue in Engineering Education (DIUS, 2008; NSF, 2009). As a consequence of this there is a severe shortage of young people entering the Profession particularly at graduate level (Davis, 1996; Thom, 2001; Beraud, 2003). Yet at a time when Engineering is struggling to attract more young people, research conducted by Engineering UK found that in the UK, only 9% of Engineering Professionals are women, compared to 18% in Spain, 26% in Sweden and 20% in Italy (Jackson, 2010). This low figure in the UK reflects that of the USA where only 11% of Engineers are women (Fouad & Singh, 2011) and in Australia where 14% of Engineers are women (Engineer Your Career, 2009). Looking at these statistics it is evident that something needs to be done to make engineering a more appealing option for young women – particularly in the UK, but also more widely.

The debate about why young women are not attracted to engineering mostly focuses around issues of gender, with the profession stereotypically perceived as being more suitable for men (NAE, 2007; Burke & Mattis, 2008). Other barriers preventing women from entering the profession have been identified as: a lack of opportunity and career progression, augmented by difficulties balancing family

and work life (Fouad & Singh, 2011); women's low self-confidence and a gender-role socialisation (Bell et. al, 2003); a lack of suitable female role-models (Bell, 2009); and, from a Scandinavian perception, inequities in 'power' relations between men and women, and different 'value systems' between the genders in engineering, with men viewed as being in a more powerful position manifested by a patriarchal bias at all levels of the Profession (Horby et. al, 2010).

Starting with the research question '*Why aren't young British women attracted to Engineering?',* this paper seeks to critically analyse the issues around gender and engineering from a UK perspective. Hence, it looks particularly at the attitudes and perceptions of young women. In doing so it begins to make a notable contribution to debates in this area.

Methodology

In seeking to identify and analyse why young British women are not attracted to engineering a Participatory Research approach (Cornwall & Jewkes, 1995) was adopted. This involved employing two 17 year old female High School students as interviewers. The girls, who were employed over their summer vacation period, were given training in how to conduct an interview and in the basic 'practicalities' of qualitative research (including the logistical aspects, such as arranging appointments, recording interviews and transcribing verbatim discussion). Additionally, an interactive 'thought-shower' session was arranged during which the girls and the two researchers worked together to consider in some detail, the issues from the girls' own ontological and epistemological perspectives (although neither of these terms were used in the session). Following this session the two girls developed a qualitative interview guide which was used through-out the interviews.

In total, twenty young women aged 16 and 17 years were interviewed. All of the girls were British, 4 were from Black or Minority Ethnic Backgrounds (BME), the rest were White. The girls were from two very different Schools. Half originated from a prestigious State Girls Grammar School (School 1) which has a demanding entrance examination and only accepts very high achieving pupils. The remaining interviewees were from a mixed Church of England School (School 2). This second School, which is also in the State Sector, takes children of mixed abilities. Like the first School, the second School is also classified as 'Outstanding' by the School Inspectorate. Both Schools were located within the same city and are located about 4 miles apart. Two high achieving Schools were purposefully selected for the study in order to allow for a reasonable comparison. Both Schools attract young people from a range of ethnic groups, religions and social classes.

The interviews took place over a three week period. Each lasted between 30-45 minutes. The interviews were recorded and transcribed. The data was analysed, by the two researchers, using qualitative techniques.

Findings

The participatory approach afforded a depth of insight and data that had not previously been available. By employing two teenage girls to talk to other teenage girls about engineering, the researchers were able to 'draw' out a living perspective in which the issues were looked at through the eyes of the target sample group. This approach proved successful and many different issues were raised and discussed.

This paper focuses on three of the main themes that have emerged from the data: Making the transition from Primary to Secondary Education: Girls' perceptions of Science at Secondary level: and, Engineering as a career choice. It gives a snapshot of the project findings – providing a brief insight into the issues from the perspectives of the sample group themselves.

- Making the transition from Primary to Secondary Education

In reflecting upon their experiences of making the transition from Primary to Secondary Education the two interviewers identified that the way in which Maths and Science were taught in Primary School differed markedly to the learning and teaching approaches at Secondary level. Thus, their interviews started off by exploring this issue in some depth.

The interviews began by encouraging the girls to think about how, and when, Science and Maths were first taught at infant and junior level. For many of the girls, their first experiences of Science was at around the age of 6 or 7 – with learning focusing mostly on Biology and botany:

> *We just looked at plants that we had in a garden and how many there were in certain areas … … it was just random really.*
>
> Mel. 17 years. School 2.

> *I remember in Year 2, we used to look at the body and how it works and how things move… …*
>
> Roshni. 16 years. School 2

> *[In Primary School]… we had lessons on Science…. from what I can remember, the focus was really on Biology, like animals and things. We didn't really do much Chemistry or think about the way things worked.*
>
> Jodie. 16 years. School 1.

With regards to Maths at Primary level, almost all of the girls described a pedagogy based upon 'rote' learning:

> *In Primary School you just listened to what the teacher did and you did the same.*
>
> Sahar. 17 years. School 1.

> *In maths, at Primary School we used to only do Adding, Subtracting, Multiplying and Dividing.*
>
> Sonya, 16 years. School 1

> *It was very specific and I suppose in Primary School you just sort of learnt it and it was like 'look it happens'*
>
> Mo. 17 years. School 2.

Having been introduced to Science and Maths at a somewhat basic level at Primary School, most of the girls found the transition between Primary and Secondary level somewhat challenging:

> *Well, [at Secondary School] Science obviously it split into Chemistry, Biology and Physics - which was a whole new concept because I had no idea…*
>
> Tessa. 16 years. School 1

Science got harder and stricter in Secondary School… It became less interactive you had to do more listening than just doing practical stuff.

Ellen. 16 years. School 2.

Maths, it was the same layout, but it got harder and you knew more about the specification; and Science, in Primary School it was very basic, we didn't know the difference between Biology, Chemistry and Physics. At Secondary School we do experiments like in Primary School, but it became more intense and more specified.

Sonya. 16 years. School 1.

Maths & Science got harder, I think I found them much easier in Primary School where I was better at them and I went down in High School, I wasn't as good at them. They got more complicated and there were some things that I didn't really understand.

Jen. 16 years. School 1.

Such challenges were echoed throughout the interviews, acting as a negative influence on the girls' perceptions of Maths and Science.

- **Perceptions of Science at Secondary Level**

For all of the girls, having made the transition from Primary to Secondary level education, Science education changed markedly, from being a single-focused subject to being multi-disciplined and more complex:

Science changed a lot. It became 3 Sciences, whereas in Primary School it was one subject of Science, so it was a big change.

Mel. 17 years. School 2.

Having been introduced to the three different disciplines, many of the girls found that they preferred either Biology or Chemistry to Physics. The reasons for this varied greatly:

I prefer Biology because it is very relevant to everything. I suppose Chemistry is as well, which I enjoy, but Biology is very relevant to everything. I find it interesting because you come across things in Science all the time but you don't always think about how they happen. I enjoy Physics the least, I don't know why as I always did best in Physics but I just didn't find it as interesting. It was the least useful for the career I wanted to go into and I never really found it as enjoyable.

Sonya. 16 years. School 1.

I prefer Biology. Definitely. It's there, you can see it. With Physics, you can't see the forces, with Chemistry you can see the experiment but I don't find it as interesting. But with Biology, you can see how it works on your own body and stuff.

Jodie. 16 years. School 1.

> *Between Biology and Chemistry, I enjoyed the practical side of Chemistry but I enjoyed learning about the body in Biology, so more Biology probably, dissecting and cutting things up. I didn't really enjoy Physics though. It wasn't as interesting, it just wasn't. You learn Physics but it's not practical based as much and it's not as interesting… It's things you can't see whereas I prefer things you can see….*
>
> Mel. 17 years. School 2.

> *I liked blowing things up in Chemistry but I also enjoyed dissecting an ox's heart in Biology because you got to see things like what they are what they're really like, and it's totally different to a diagram. Physics was my worst subject. I don't know why but Physics always used to scare us about nuclear bombs and thing like that, what the outcome would be if there was one which was all a bit scary…*
>
> Sahar. 17 years. School 2.

> *I like Physics the least. It is the hardest and some of the things seem quite obscure to me. They were things that I didn't want to do, that I wasn't interested in. It was the calculations and equations, there are a lot of them to memorise, which is not as interesting as getting involved with the subject. With an equation, you write it down and memorise it whereas with Biology, it's with the body and you can get a bit more involved with it. You can bet into it a bit more.*
>
> Emily. 16 years. School 1.

Of all the girls interviewed, only three preferred Physics to the other Sciences:

> *I chose Physics because I am good at it and I really enjoy it. Maths the same. Chemistry because I might need it for the university course I want to do and classics because I really enjoy the lessons. But I enjoy Physics the most. I find it really interesting, especially the space topic. And I find it the easiest as well.*
>
> Belle. 16 years. School 1.

> *I think I became more open minded with Physics as I got older. Before that, I didn't like the teachers and that made me take it out on the subject - so I didn't even bother trying. Then at GCSE I knew I had to do well, which made me concentrate and then I realised that I love Physics.*
>
> Kelly. 16 years. School 1.

> *I enjoyed Physics the most mainly because of the teacher that I had but also because it was learning about the outside world and what effects it has on it.*
>
> Mo. 16 years. School 2.

The girls' preference towards Biology reflected their wider work and career interests. Furthermore, the interviews revealed that that it is not Physics itself that girls disliked (although there were some aspects which they found 'scary' such as the lessons on Nuclear War), but they were instead put off by the way in which the subject was taught. Most of the interviewees perceived Physics to be an abstract subject, of little or no relevance to their lives.

- **Perceptions of Engineering as a Career Choice**

The girls' views on Engineering as a career choice varied. Some perceived it to be a 'masculine' domain:

> *There are some female prejudices against Sciences, against engineering especially. I think people don't think it is as important as stuff like medicine and so they don't even bother thinking about Physics.*
>
> Kelly. 16 years. School 2

Whilst others believed that girls could become Engineers if they wished:

> *… If you're a girl and you want to be an Engineer, then I don't think that it's kind of a subject where people can say you're a girl so you can't do engineering - because you can try anything these days,*
>
> Mo. 17 years. School 2

Although the majority of the girls believed that women could be Engineers if they so wished, none viewed it as a viable career option for themselves; indeed, only one of the twenty had even considered it a possibility:

> *I did think about it, when it came to A-Level choices I was very tempted to take some Sciences and maths because I felt that I should follow my Dad's footsteps and go into Engineering and obviously I went into Dad's office all the time so I knew quite a lot about it. I used to see all the funky posters on the wall so I did consider it but as I went through GCSEs I found where my strengths lie, where the things that I enjoy lie and I guess I realised that it just wasn't for me"*
>
> Tessa. 16 years. School 1

For the others, Engineering had never been realistically considered:

> *No, I haven't considered engineering as a career as it's more hands on. Optometry is people's eyes. Engineering is more machinery. I just have not considered it. I think I haven't considered it as much because I want to work with people and help patients, people who need help, which is probably why I want to do Optometry.*
>
> Sahar. 17 years. School 2.

Discussion & Concluding Remarks

In considering how teenage girls view both Engineering as a discipline and as a potential study and career choice, the most notable factor shaping their perceptions was a lack of knowledge, exposure and experience. In the UK, as elsewhere, Engineering is simply not on the School Curriculum – hence it is not something girls think about. Whilst Science and Maths is compulsory from the age of 5 to 16 years, over half of the girls 'dropped' Maths as soon as they could. Furthermore, only one had selected to study Physics beyond the age of 16 (she wanted to become a Scientist, not an Engineer). Of the rest, over half were studying at least Biology or Chemistry at 'Advanced' level – with their career choices varying from Physiotherapist, Psychologist, Optometrist to Medical Practitioner. The study has shown that one of the issues that urgently needs addressing relates to children's transition from Primary to Secondary School. Children perceive Science very differently in Primary School, often

losing interest when they reach adolescence. Clearly, if more young people are to be encouraged to consider Engineering as a career then more needs to be done to maintain and develop children's interest beyond the age of 12 or 13 years. The ways in which this could be achieved undoubtedly merit further empirical investigation. However, we believe that a more hands-on pedagogical approach, in which girls and boys are encouraged to experience the excitement of Engineering and Science from an early age, is needed. Experiential learning should not diminish when a child reaches the age of 11, and enters Secondary Education. For children's enthusiasm and interest to be maintained and developed, Education needs to be both relevant and realistic - with key Scientific and Mathematical principles embedded within a wider social context. This can be achieved by introducing Engineering into the Curriculum at Primary and Secondary levels. Indeed, Engineering provides the ideal context in which Science, Maths and other Disciplines (including History, English and ICT) can be experienced in a practical and meaningful way.

Most of those interviewed had a vague idea what Engineering was, but on the whole their perceptions were inaccurate, possibly reflective of the industrial area in which they were Schooled. This study has shown that there is a dire need to raise children's awareness of what Engineering is, both as a Discipline and as a Profession. Whilst all of the girls interviewed believed women could be Engineers, none wanted to enter the Profession. However, that half wanted to follow careers in Science, Medicine or Health, and that they all achieved relatively highly in Maths and Science at the age of 16, suggests that all of the sample could potentially become Engineers if they so wished. The question is: *How can the Profession encourage more young women such as those interviewed to seriously consider a career within Engineering*? Whilst this study has shown that there are no simple solutions to this issue, one thing that has become apparent is the lack of positive Engineering Role-Models (both female and male) that children have access to. Most children have simply never met an Engineer! This is one issue that the Profession can do something about – by encouraging young Engineers, both female and male, to go into Schools to work with teachers and children. Only by raising the profile of the Profession, and by educating young people about Engineering, will future shortages be averted.

In conclusion, whilst there is a need for the Engineering Profession to assure its sustainability by attracting both young men and women, that young women do not, at present, perceive Engineering to be a viable career option represents a serious challenge for both Engineering Education and for the Profession itself. Indeed, it is clear that if the Engineering Profession is going to begin to address future predicted shortages there is no doubt that it needs to attract young women. Not to do so could have serious implications for society as a whole. The emergent findings from this study suggest that first step in addressing the issues is to look closely at the School Curriculum. Indeed, for girls to consider Engineering as a potential and viable career option the subject first needs to become embedded within their everyday language and learning. Only then will gender disparities in the Profession begin to be addressed – and future shortages of Engineers be avoided.

References

Bell, A.E., Spencer, S.J., Iserman, E., LOGEL, C.E. R. (2003). "Stereotype Threat and Women's Performance in Engineering". *Journal of Engineering Education.* October. pp. 307-312.

Bell, S. (2009). *Women in Science in Australia.* Federation of Australian Science & Technological Societies. Australia.

Beraud, A. (2003). "A European Research on Women & Engineering Education". *European Journal of Engineering Education.* 28. 4. pp 435-451

Burke, R. & Mattis, M.C.(2008). *Women and minorities in Science, technology, engineering and mathematics: Upping the numbers.*

Cornwall, A. & Jewkes, R. (1995). "What is Participatory Research?" *Social Science and Medicine.* 41. 12. pp 1667-1676

Davis, C. (1996). *The Equity Education: Fostering advancement of women in the Sciences, maths and engineering.* San Francisco. Jossey Bass

DIUS. (2008), *A Vision for Science and Society*, London, The Royal Academy of Engineering, Department of Innovation, Universities & Science.

Engineer Your Career (2009). *Women in Engineering.* Available from: http://www.engineeryourcareer.org.au/?page_id=90 Accessed 14th May 2012.

Fouad, NA., Singh, R., (2011). *Stemming the tide: Why Women Leave Engineering.* National Science Foundation & University of Wisconsin, Milwaukee. Downloaded 10th May 2012 from: http://energy.gov/sites/prod/files/NSF_Stemming%20the%20Tide%20Why%20Women%20Leave%20Engineering.pdf

Hørby, M., Madsen L., Dahms M. (2009). *Engineering education - out of the Male Reserve!*. Available from: http://www.sefi.be/wp-content/abstracts2009/Dahms.pdf Accessed 14th May

IMechE. (2009). *Education for Engineering: IMECHE Policy Summary*. London: Institute for Mechanical Engineering.

Jackson, P. (2010). *EngineeringUK to investigate why UK has lowest number of female engineers in Europe.* EngineeringUK. Accessed 10th May 2012 from: http://www.engineeringuk.com/_db/_documents/Final_CRAC_PR_210410_v2BE_(4).pdf

National Academy of Engineering (2007) *Beyond Bias and Barriers: Fulfilling the potential of women in academic Science and engineering.* Washington. NAE & National Academy of Science. Cheltenham. UK. Edward Elgar.

NSF. (2009), *Closing the Gender Skills Gap: A National Skills Forum Report on Women, Skills and Productivity*, London, National Skills Forum.

RAEng, (2008). *Engineering*. House of Commons Committee on Innovation, Universities, Science and Skills. London. Royal Academy of Engineering.

Spinks, N., Silburn, N. & Birchall, D. (2006). *Educating Engineers for the 21st Century: The Industrial View.* London: Royal Academy of Engineers.

Thom, M. (2001). *Balancing the Equation: Where are the women and girls in Science, technology and engineering?* New York. National Council for Research on Women

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